



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/036,388	01/07/2002	Takenobu Kishida	60188-415	3663

20277 7590 02/12/2004

MCDERMOTT WILL & EMERY
600 13TH STREET, N.W.
WASHINGTON, DC 20005-3096

EXAMINER

CAO, PHAT X

ART UNIT	PAPER NUMBER
----------	--------------

2814

DATE MAILED: 02/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/036,388

Applicant(s)

KISHIDA ET AL.

Examiner

Phat X. Cao

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 November 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 19-30 and 37-51 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 19-21, 23-27, 29, 30, 37-41 and 43-51 is/are rejected.
- 7) ☐ Claim(s) 22, 28 and 42 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 8/29/03.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

1. The cancellation of claims 31-36 in Paper filed 10/06/03 is acknowledged.

Claim Rejections - 35 USC § 112

2. Claims 44-51 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

In the base claim 44, the limitation of having the barrier layer directly contacting the conducting film after annealing step is not supported by the original disclosure.

3. Claims 44-51 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The limitation of having the barrier layer directly contacting the conducting film after annealing step (base claim 44) is unclear. It is unclear that why the conducting film (i.e., Cu) will not react with the barrier layer (i.e., Ta) to form an interfacial layer after annealing step at a temperature of 150 degrees C for 60 minutes (see specification). In the other words, it is unclear that how the barrier layer will directly contact with the conducting film if the interfacial layer is formed by the reaction between the barrier layer and the conducting film at the annealing temperature of 150 degrees C for 60 minutes. Therefore, if Applicant believes that there is no interface reaction between the barrier layer

and the conducting film at the annealing temperature of 150 degrees C for 60 minutes, then Applicant is requested to support that position with facts.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

5. Claims 44-49 are rejected under 35 U.S.C. 102(e) as being anticipated by Tagami et al (US. 6,538,324) – previously cited by the examiner in PTO-892.

Tagami (Fig. 4D) discloses a semiconductor device, comprising: an insulating film; a conducting film 18 of copper formed in a recess and on the insulating film, wherein the recess comprises a plug formed in a via hole and an interconnect formed in the interconnect groove; and a barrier layer 16 is made from a tantalum film having a beta-crystal structure (column 13, lines 57-61 and column 12, lines 15-23), and wherein

the barrier layer 16 directly contacts the conducting film 18 (Fig. 4D and column 9, lines 34-42).

Regarding process limitations (sequentially deposited, after the annealing step, etc.), these would not carry patentable weight in a claim drawn to structure because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964 (Fed. Cir. 1985).

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 19-21, 23-24, 37-41 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral, Jr. et al. (US. 6,437,440) in view of Kwon et al., Materials Research Society, pp. 711-716 (cited by Applicant).

Cabral (Fig. 3) discloses a semiconductor device, comprising: an insulating film (54,12) including a fluorine component (column 4, lines 17-21) and formed on a semiconductor substrate; a lower interconnect 24 formed in the insulating film 54; a via hole 11 formed on the lower interconnect and in the insulating film; an interconnect groove 17 formed in an upper region of the via hole and in the insulating film; a plug composed of a copper film 24' buried in the via hole 11; an upper interconnect buried in the interconnect groove 17; and a barrier layer 23 formed between the insulating film and the plug, the insulating film and the upper interconnect, and the plug and the lower

Art Unit: 2814

interconnect, wherein the conducting film 24' comprises copper, and wherein the barrier layer 23 is composed of a laminated film including a lower first barrier layer of tantalum nitride containing 30-60 % nitrogen (column 2, lines 49-54) and an upper second barrier layer of alpha-tantalum (column 4, lines 15-18).

Cabral does not disclose the upper second barrier layer of tantalum having a beta-crystal structure.

However, Kwon (pages 711-716) teaches the forming of copper film on the tantalum barrier layer having a beta-crystal structure. Accordingly, it would have been obvious to form Cabral's upper second barrier layer of tantalum having a beta-crystal structure because as taught by Kwon, such beta-tantalum layer would promote the adhesion of copper film and would provide large copper grains with a strong (111) texture obtained owing to the heteroepitaxial growth of Cu on the beta-tantalum layer (see abstract).

3. Claims 25-27 and 29-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral, Jr. et al. (US. 6,437,440) in view of Kwon et al (Materials Research Society, pp. 711-716) and Grill et al (US. 6,346,747).

As discussed in details above, the combination of Cabral and Kwon substantially reads on the above claims, except it does not disclose that the interlayer insulating film 12 of Cabral's Fig. 3 is divided into a first interlayer insulating film and a second interlayer insulating film.

However, Grill (Figs. 4 and 5) teaches the dividing of the interlayer insulating film 44 into two separate layers 84 and 86, and forming a plug and an upper interconnect

Art Unit: 2814

into these two separate layers (column 9, lines 24-36). Accordingly, it would have been obvious to divide the interlayer insulating film 12 of Cabral into first and second interlayer insulating layers and to form the plug and the upper interconnect into these two separate insulating layers, because as taught by Grill, such dividing would provide superior interconnect depth control (column 9, lines 24-36).

Allowable Subject Matter

4. Claims 22, 28 and 42 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The prior art fails to disclose all the combination of the semiconductor device structure recited in the above claims, including the ratio between nitrogen atoms and tantalum atoms of the tantalum nitride film as claimed.

Response to Arguments

5. Applicant argues that neither Cabral nor Kwon disclose the combination of TaN/Ta (beta-crystal)/Cu laminated layer.

This argument is not persuasive because the rejection is not based on Anticipation, but rather, is based on obviousness. The Examiner relies on the combined teachings of Cabral and Kwon. Kwon is not relied on for teaching the combination of TaN/Ta/Cu laminated layer. Cabral discloses the combination of TaN/Ta (alpha-crystal)/Cu laminated layer. Kwon is relied on for showing that it was known to form Ta (bata-crystal) barrier layer under the copper film for promoting the adhesion of copper film and providing large copper grains with strong (111) texture obtained owing to the

Art Unit: 2814

heteroepitaxial growth of Cu on the beta-tantalum layer. The Examiner thus regards Applicant's assertions as constituting evidence that Applicant has failed to consider as a whole the prior art teachings disclosed by the combining of the references.

Applicant further argues that Cabral teaches away from using beta Ta because beta Ta has higher-resistivity.

The Examiner recognizes that Cabral may not suggest the use of beta Ta for reducing resistivity. However, Cabral does not teach away from using beta Ta as a barrier layer under the conductive copper film for promoting the adhesion of copper film and for providing large copper grains with strong (111) texture obtained owing to heteroepitaxial growth of Cu on the beta-tantalum layer, as suggested by Kwon.

Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Art Unit: 2814

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phat X. Cao whose telephone number is (571) 272-1703. The examiner can normally be reached on Monday - Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

PC
February 5, 2004


PHAT X. CAO
PRIMARY EXAMINER